Climate in California: Observed Trends, Interpretation, and Future Projections

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Who am I?

My day jobs:

Physicist,
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Institute for Research on Climate Change and its Societal Impacts

Associate Adjunct Professor, U.C. Merced
School of Natural Sciences

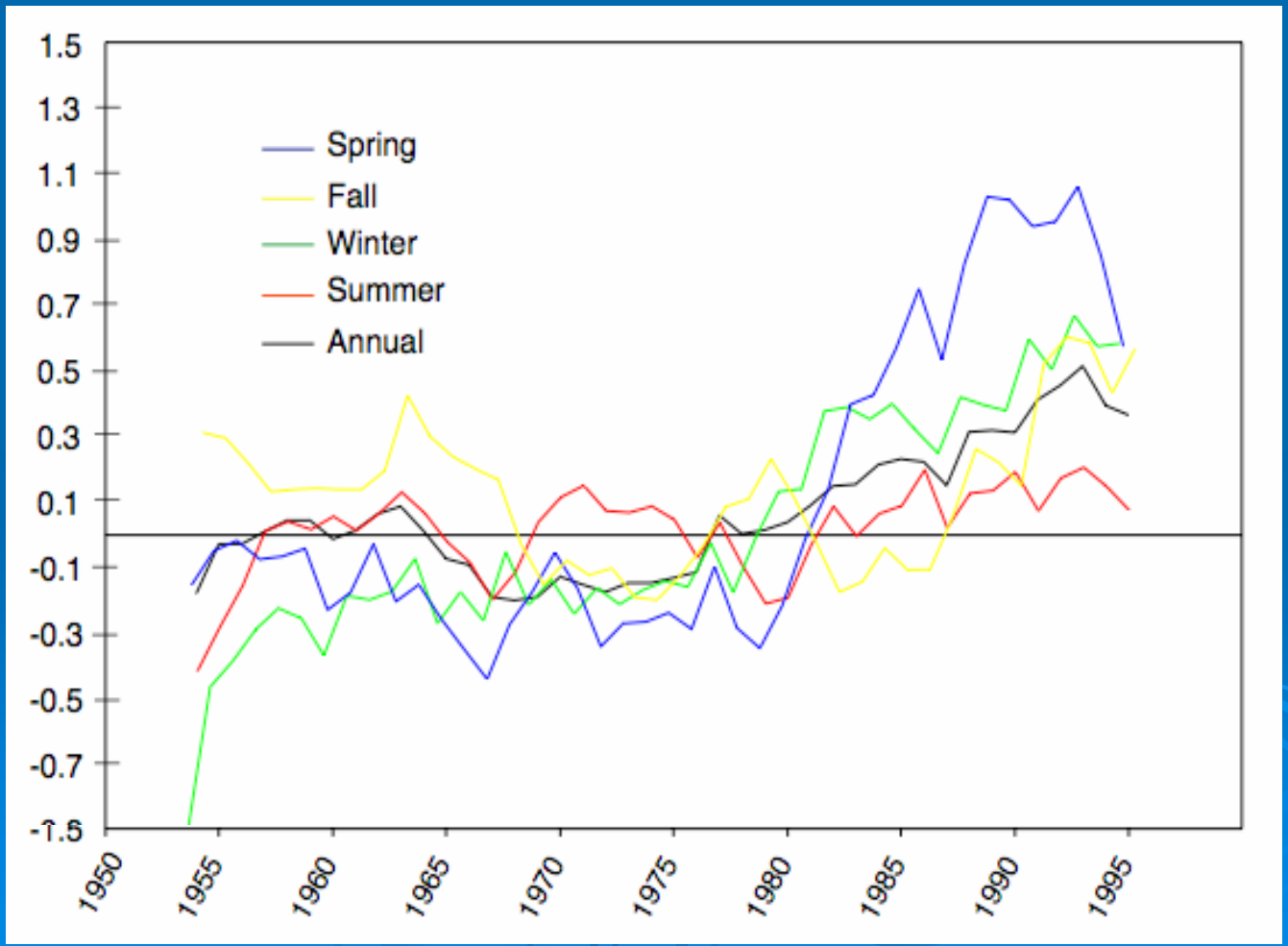
THIS TALK APPROVED FOR

The Past:

Observed Climate Trends

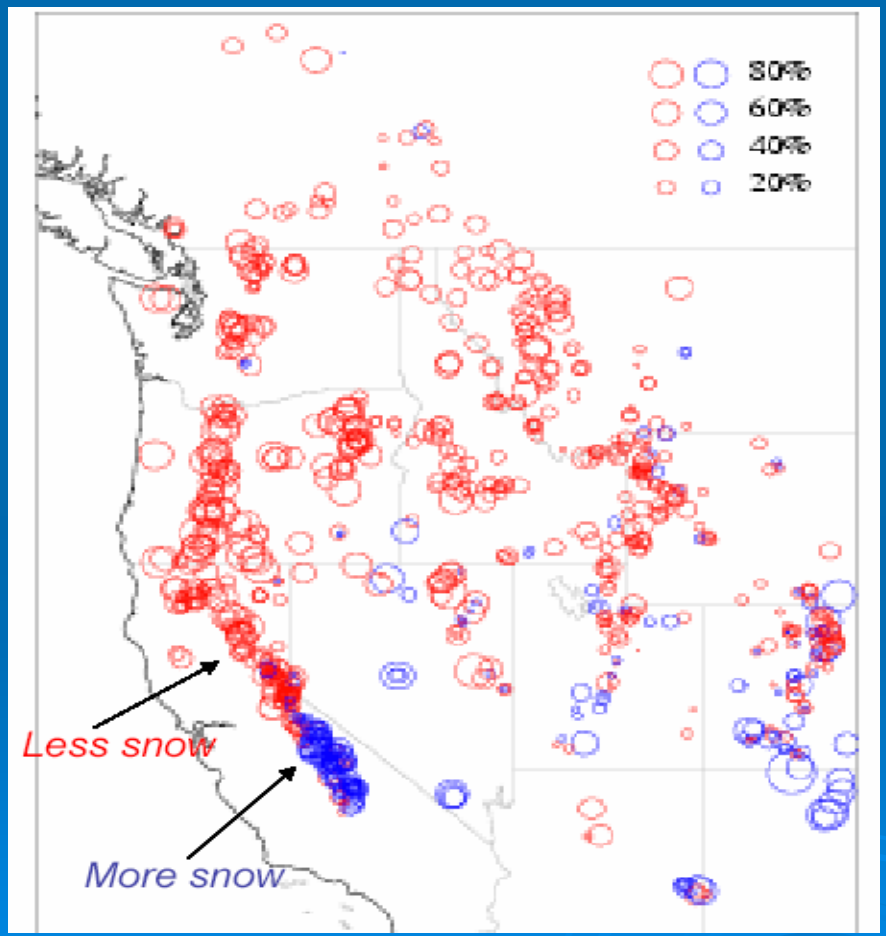
California is warming…

Average temperatures, by season



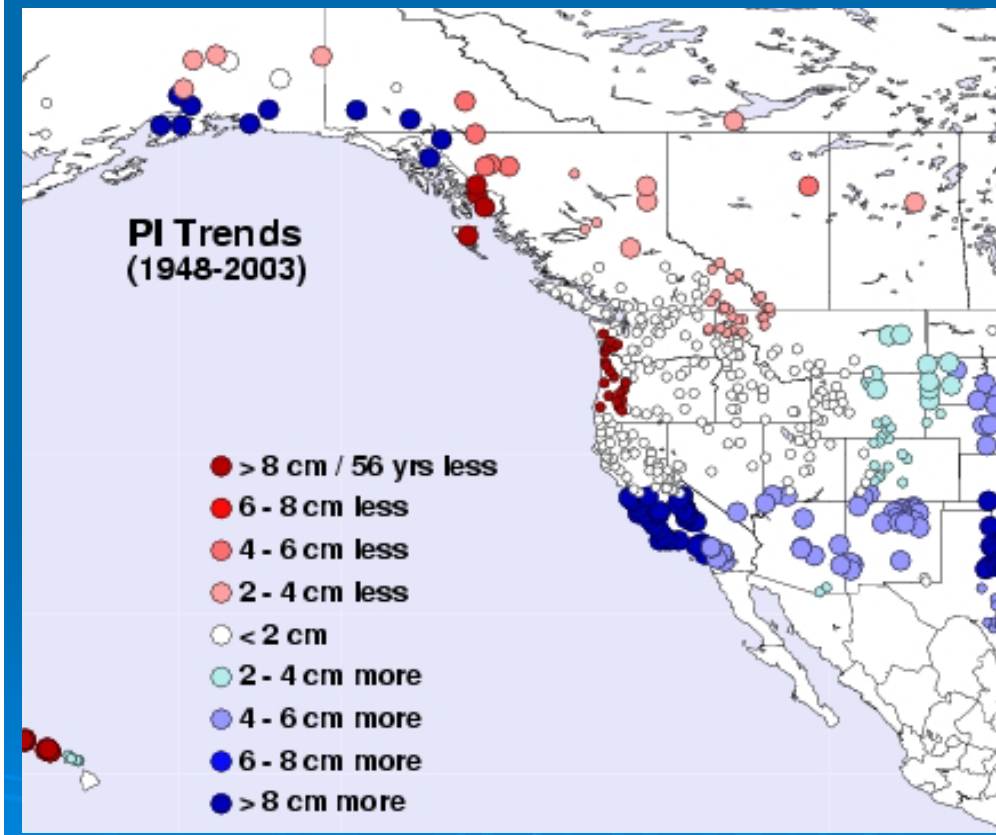
There is less snow in most of the west

50-yr trends in snow water content



Source: P. Mote, *Bull. Amer. Meteor. Soc.*, 2005

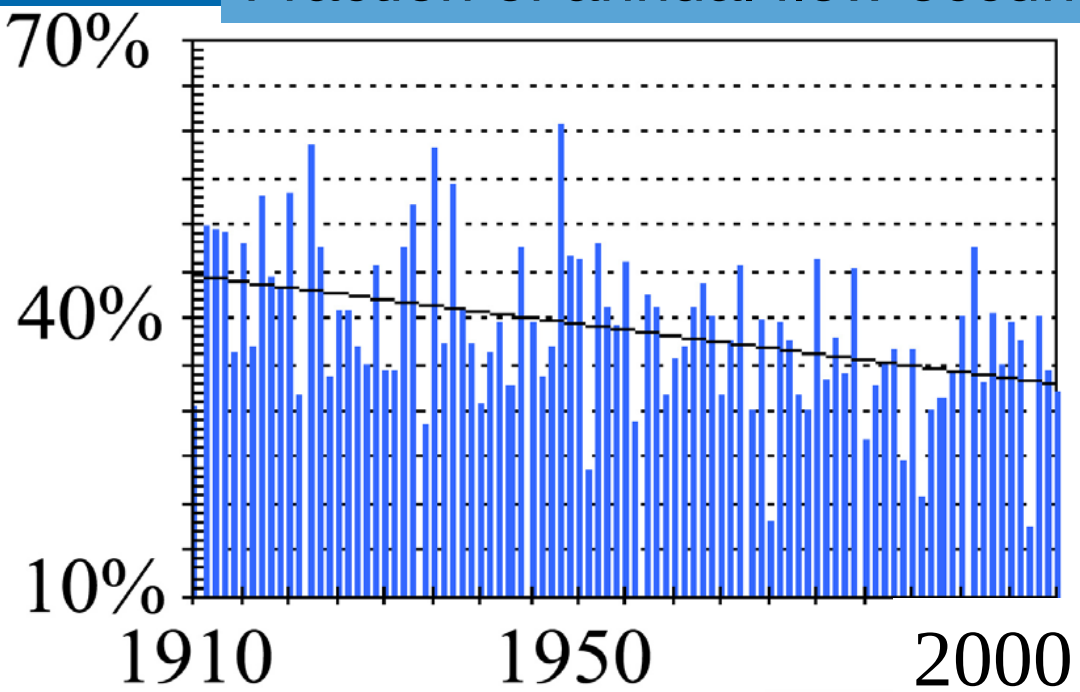
50-yr trends in precipitation



Source: Iris Stewart, UCSD

Late-season river flows are decreasing, due to warming

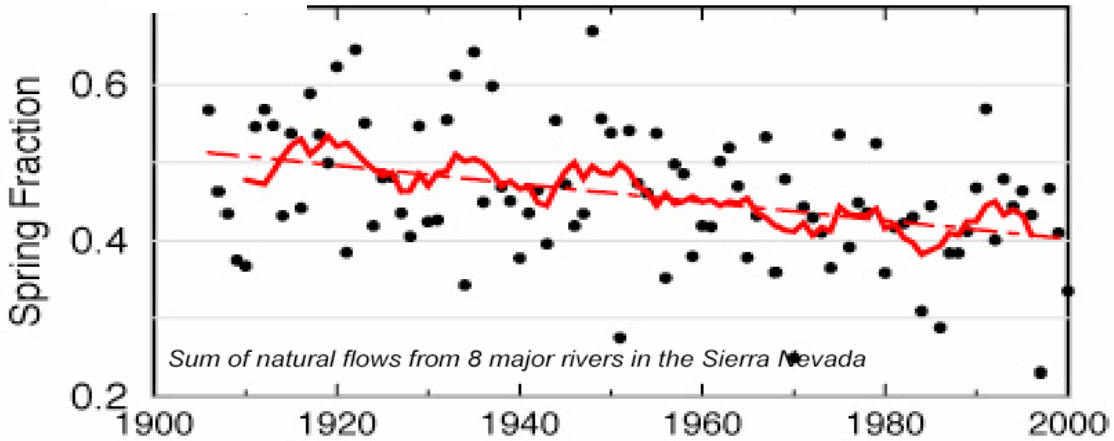
Fraction of annual flow occurring in April - July



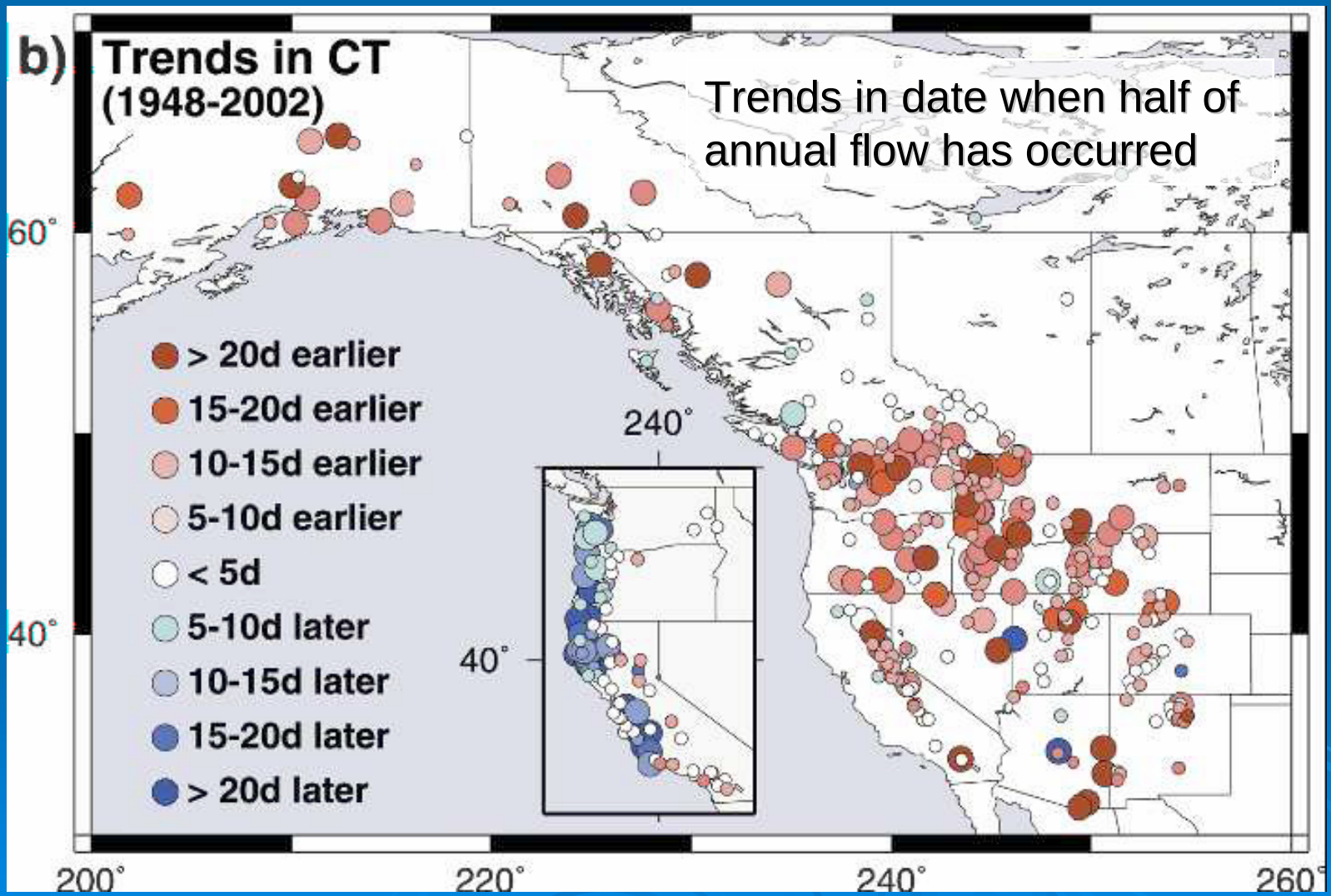
← Sacramento river system

Dettinger and Cayan, 1995

8 major rivers →



River flow is coming earlier in the year



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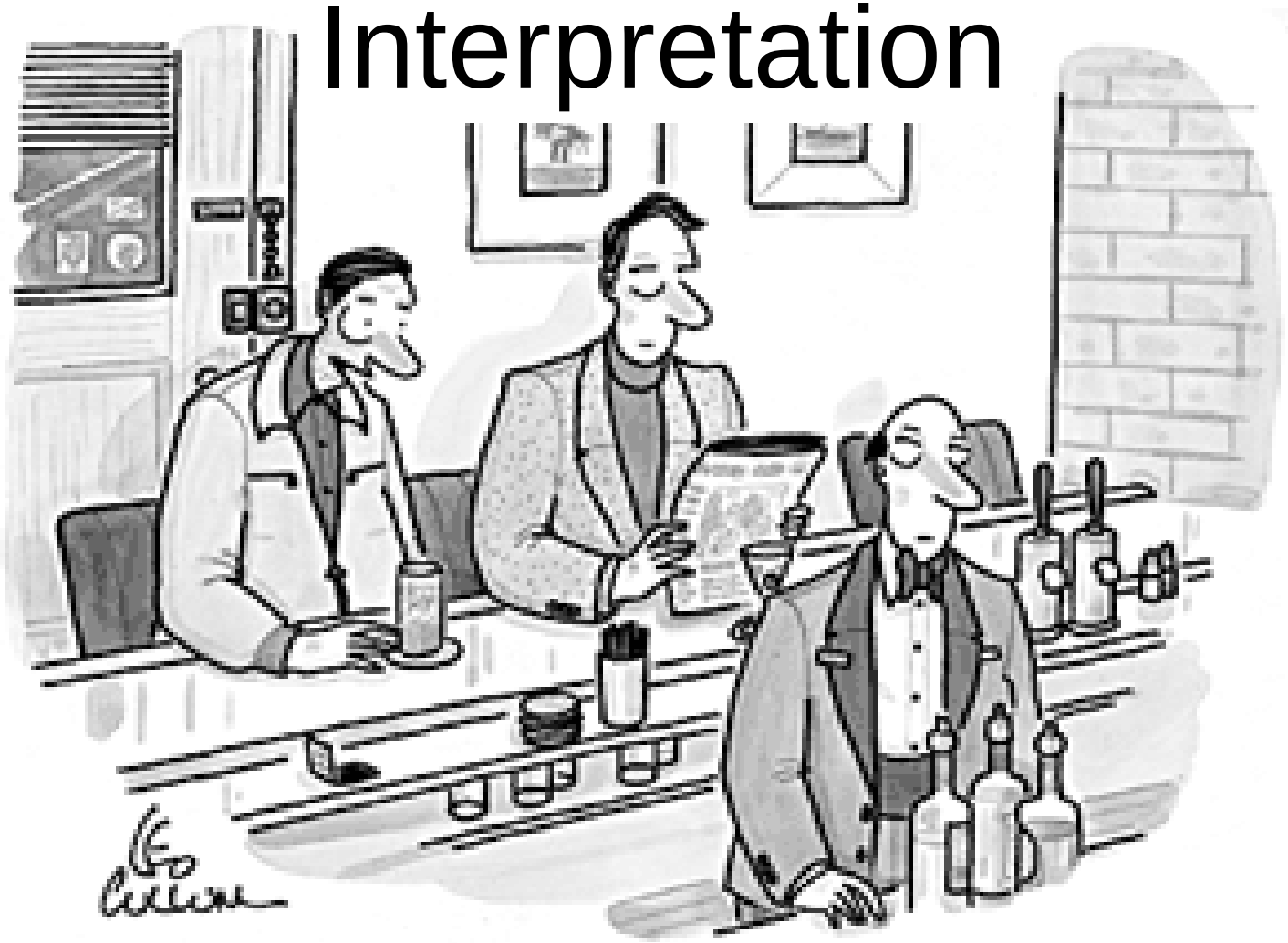
Interpretation

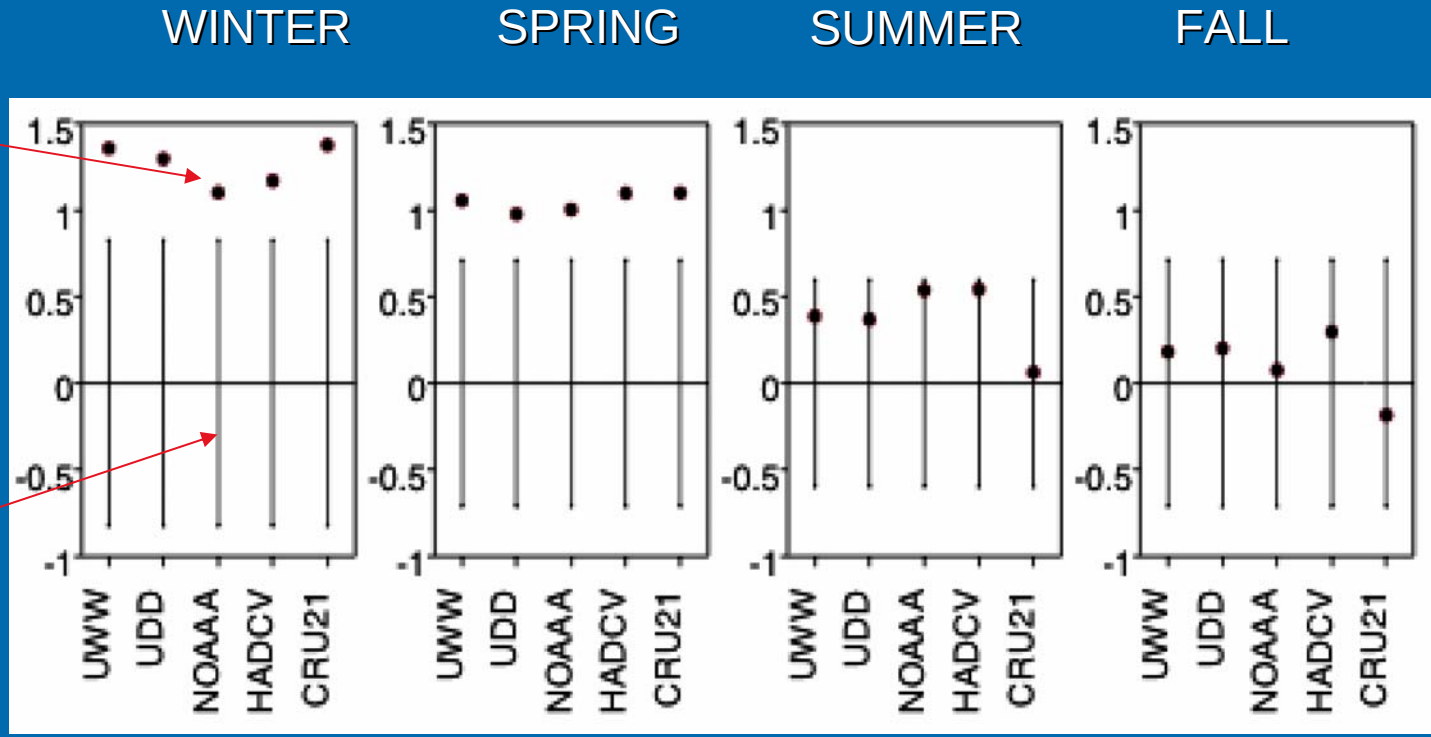


"I don't know anything about global warming, but these ice cubes are melting like crazy."

Temperature changes are faster than expected from natural climate variability

Observed trends from 5 different data sets

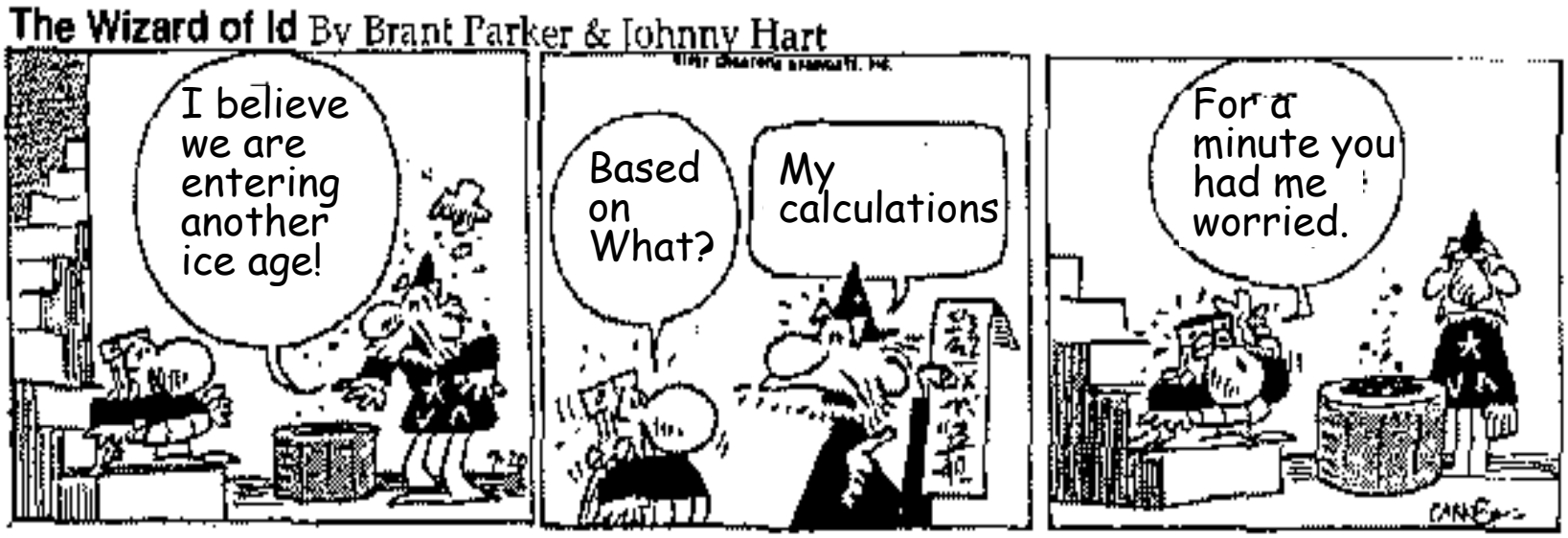
Maximum likely trend due to natural internal variability



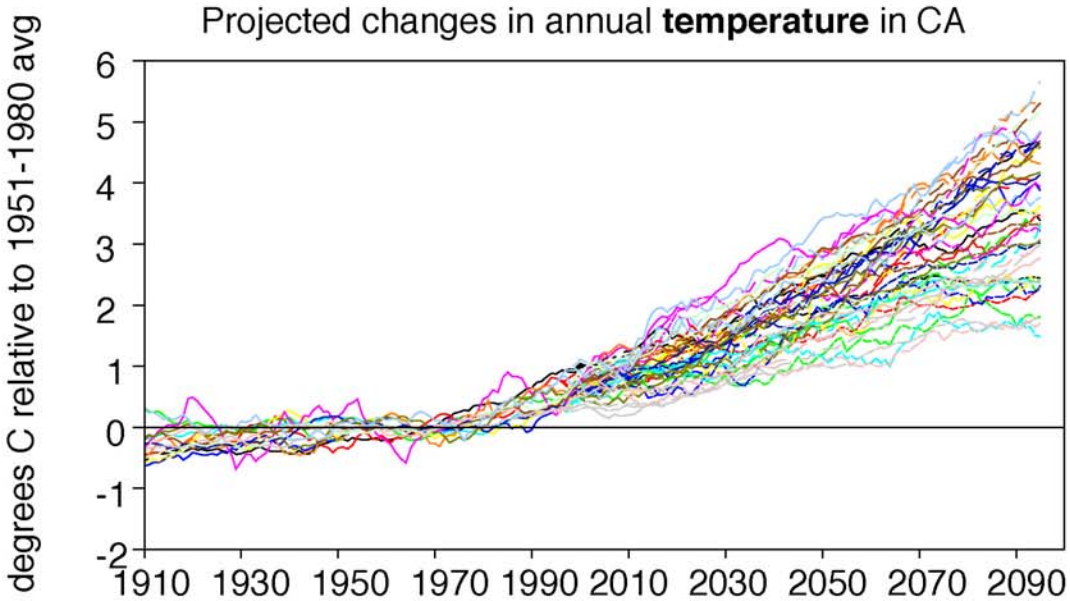
Conclusion: some external factor is contributing to winter and spring warming in California.

Source: Bonfils and Duffy, 2007, paper in press

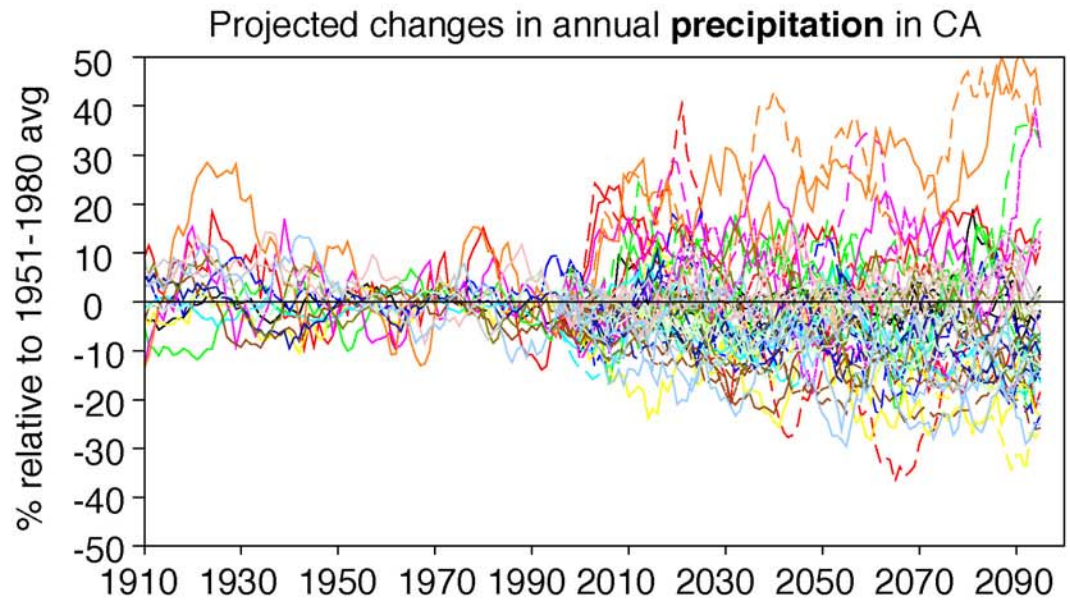
The Future

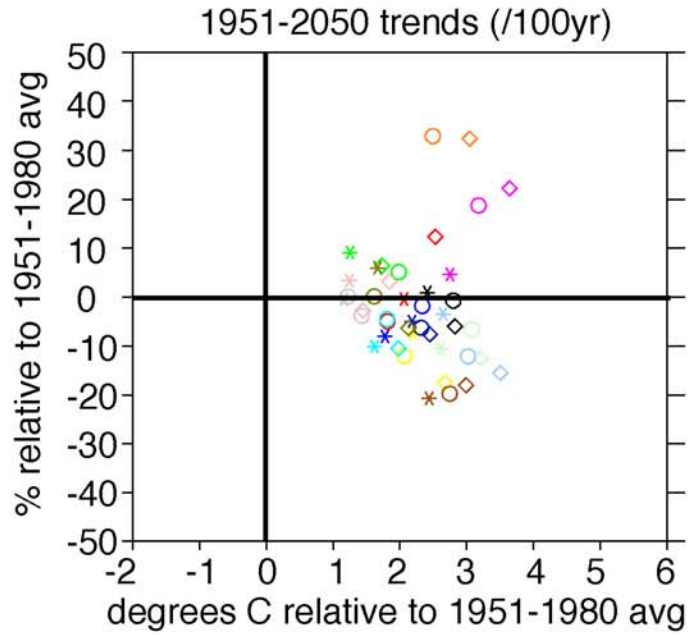


Because climate models are not perfect,
we make projections with quantified uncertainties



15 models
x 3 “scenarios”

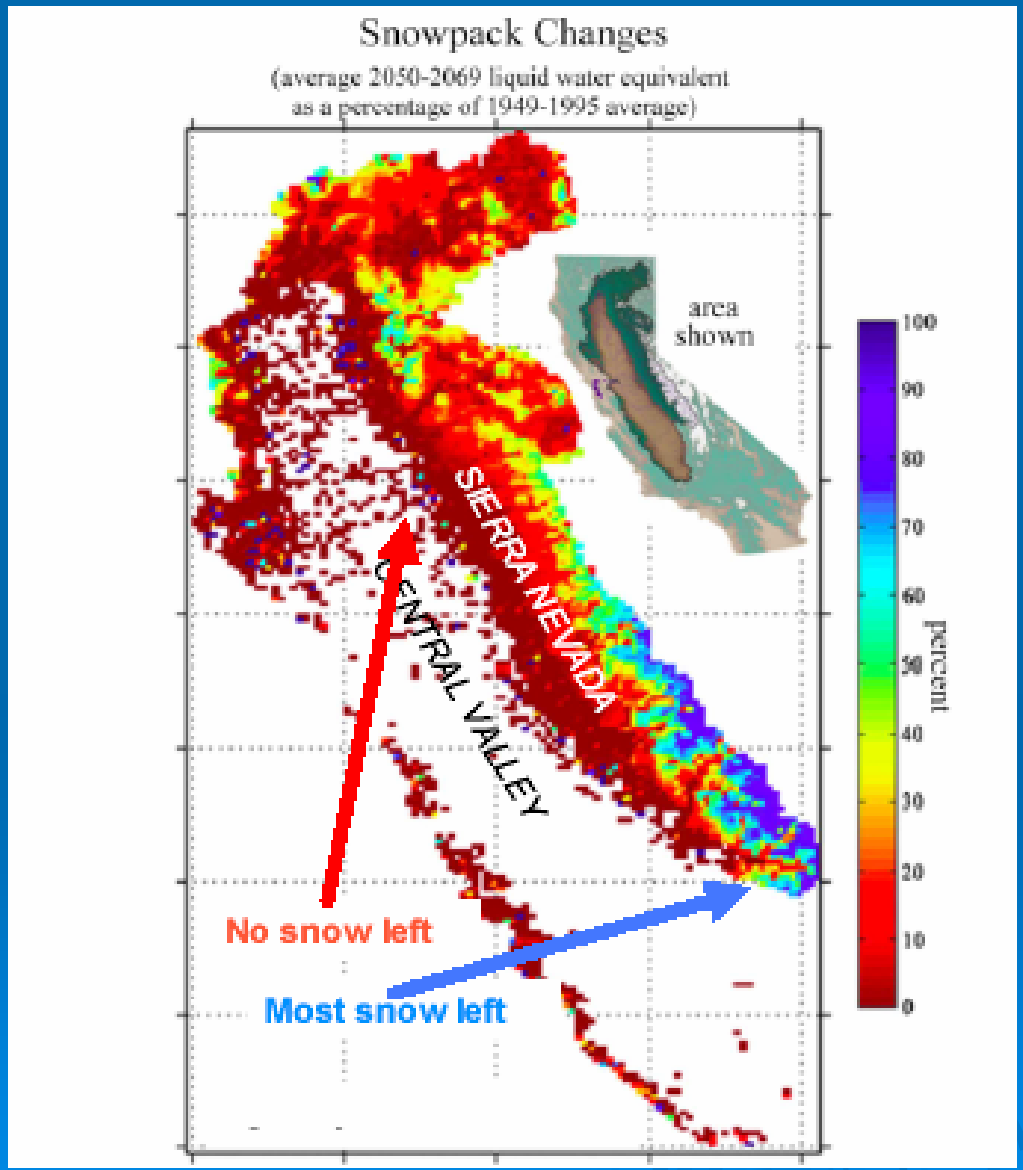




dot & star: SRESB1, solid & diamond: SRESA1B, long-dash & circle: SRESA2

Courtesy Celine Bonfils, UC Merced & LLNL

California's snowpack will melt



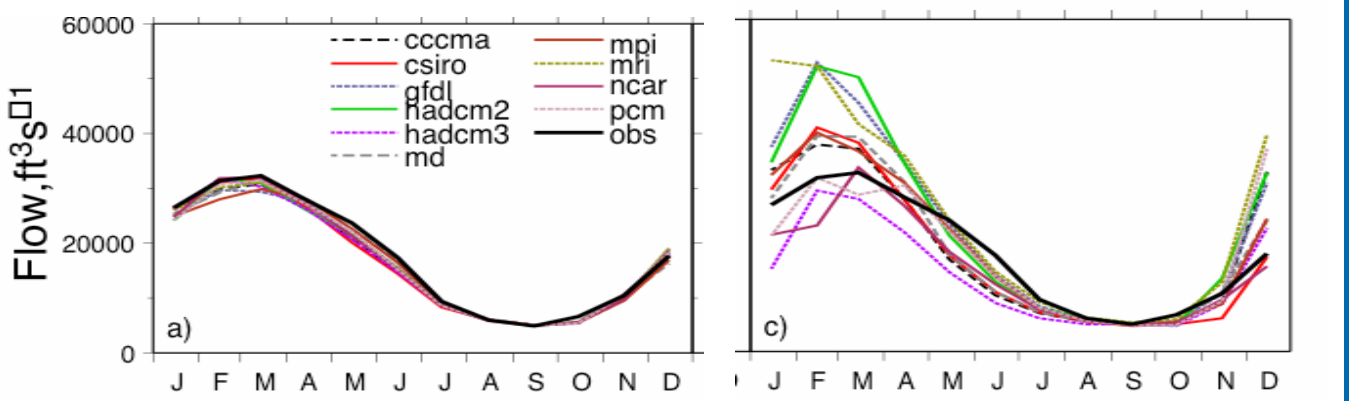
Source: Knowles and Cayan, 2002, *GRL*

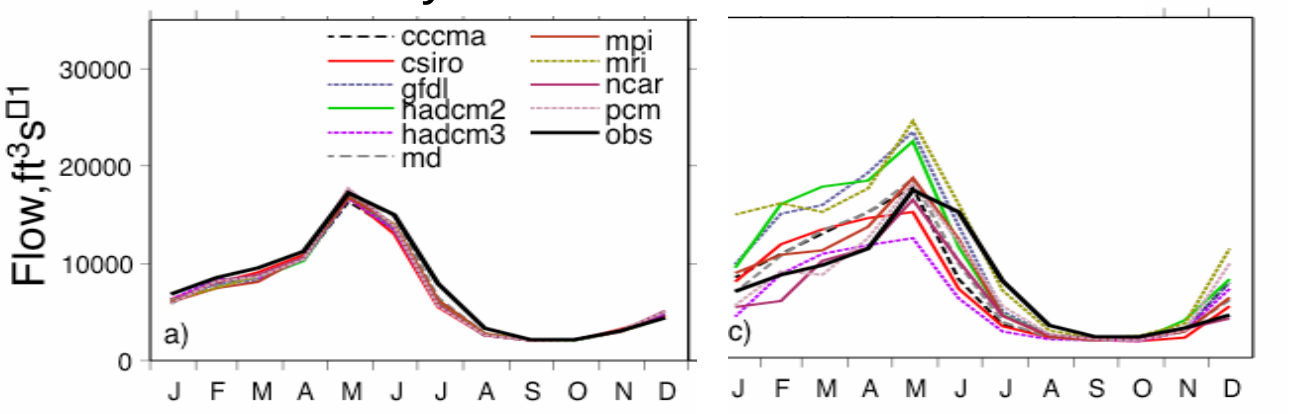
Projected snow water content in 2050-2069, as a fraction of 1949-1995 average

This is a typical projection; actual results may vary! Do not try this at home…

Model: PCM (low sensitivity)

Warming changes timing of river flows





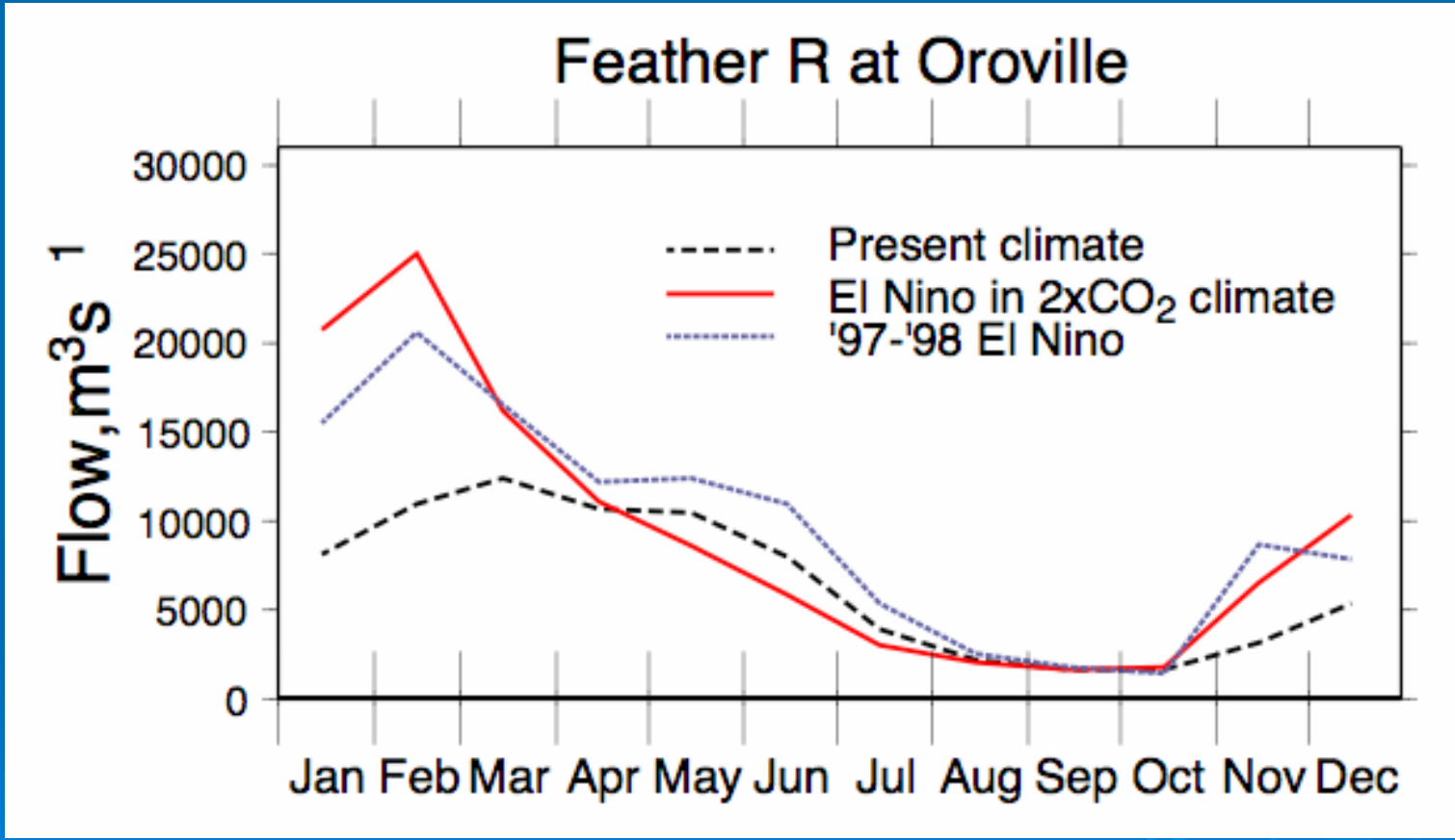
3 northern rivers

4 southern rivers

River flow simulations based on results of 10 different climate models

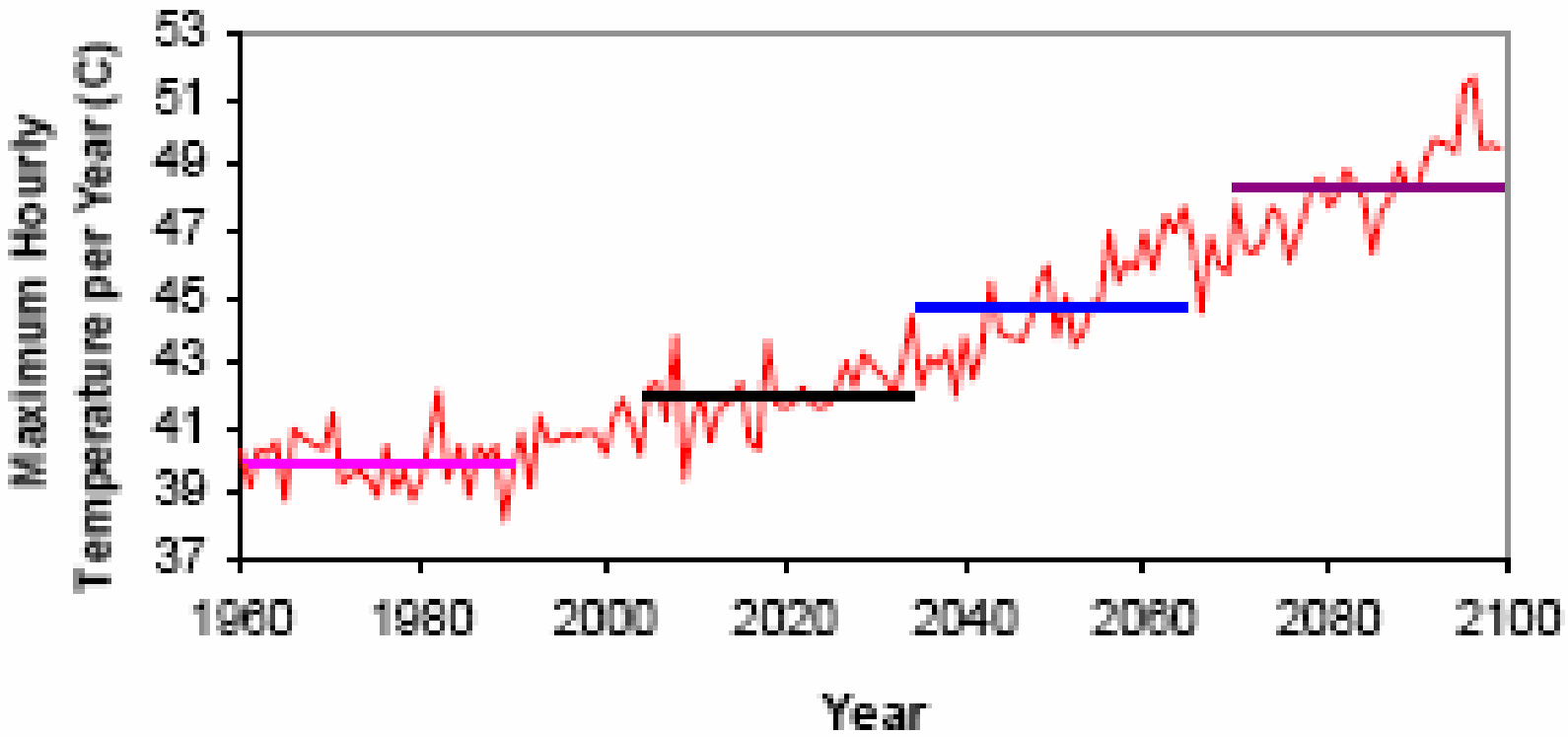
Source: E. Maurer an P. Duffy. *Geophys. Res. Lett.*, 2005

El Nino in a warmed climate: floods in winter, water shortages in summer



E. Maurer, S. Gibbard, and P. B. Duffy, Amplification of streamflow impacts during El Nino conditions in California under a warming climate, *Geophys Res Lett.*, Vol. 33, No. 2, L02707 10.1029/2005GL025100, 27 January 2006.

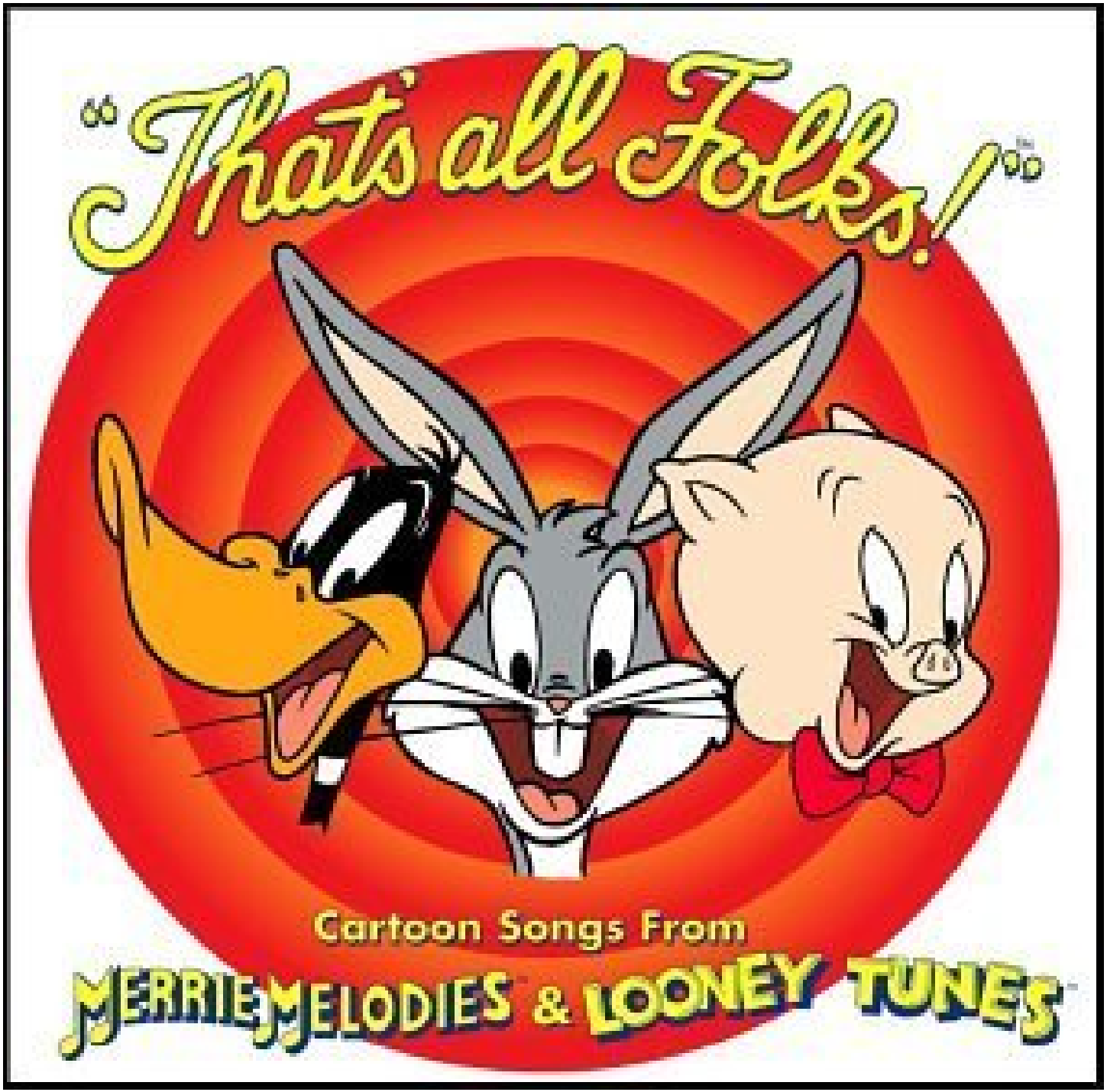
Temperature extremes are projected to increase, a lot



Source: G. Franco and A. Sanstad, *Climate change and electricity generation in California*, CEC Report

Summary: Expected climate changes

- Warmer in all seasons
- Uncertain changes in mean precipitation amounts
  - But important effects on hydrological cycle result from warming, which is much more certain
- Less snow; earlier snow melt
- Increased early-season river flows, and increased year-to-year variability in flows.
- Decreased late-season flows
- Drier summer soil; greater risk of forest wildfires
- More frequent extreme temperature and precipitation events


"That's all Folks!"
Cartoon Songs From
MERRIE MELODIES & LOONEY TUNES

Philip B. Duffy…

… is a Physicist at Lawrence Livermore National Laboratory, and Adjunct Associate Professor at U.C. Merced. He is also Director of the University of California's Institute for Research on Climate Change and its Societal Impacts (IRCCSI). He is an expert on the science of climate change and the societal impacts of climate change, particularly in California. He holds an AB degree *magna cum laude* in astrophysics from Harvard University, and a Ph.D. in physics from Stanford. He has published over 50 peer-reviewed papers on astrophysics, atomic physics, or climate change.

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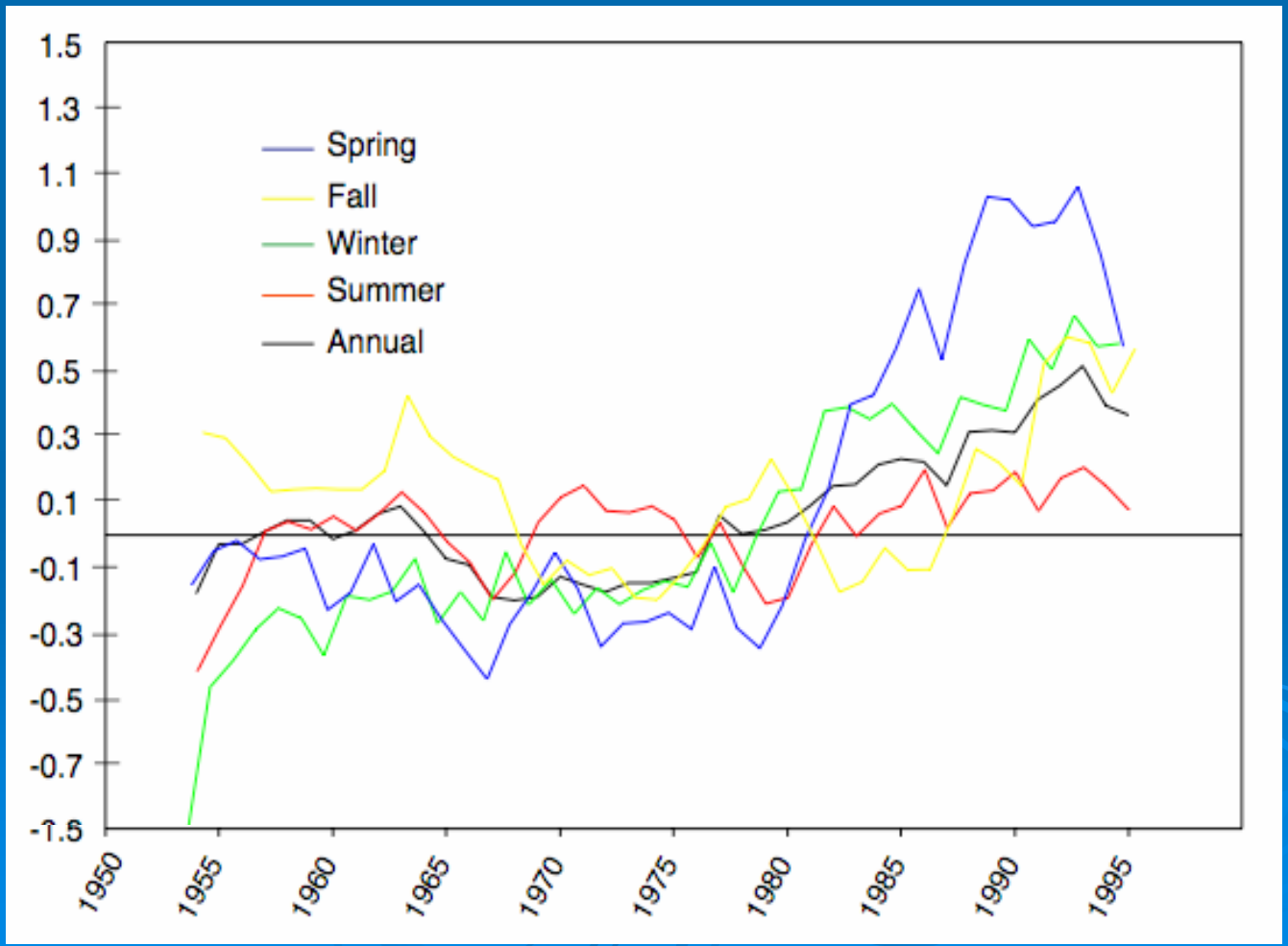

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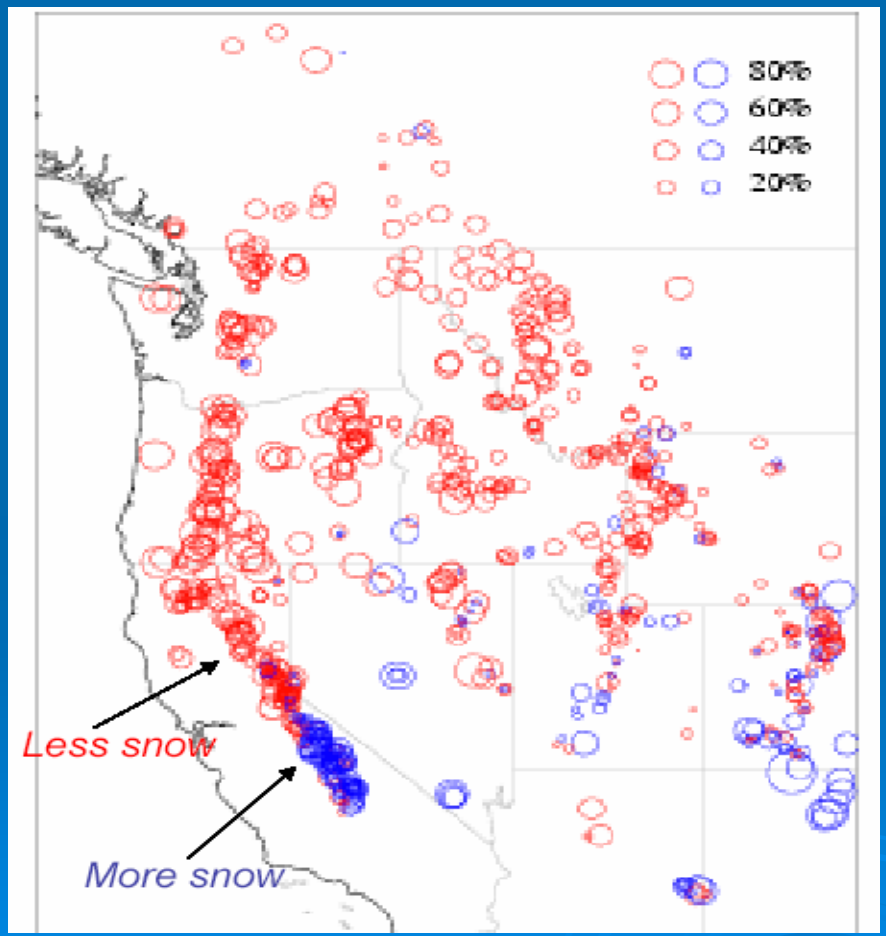

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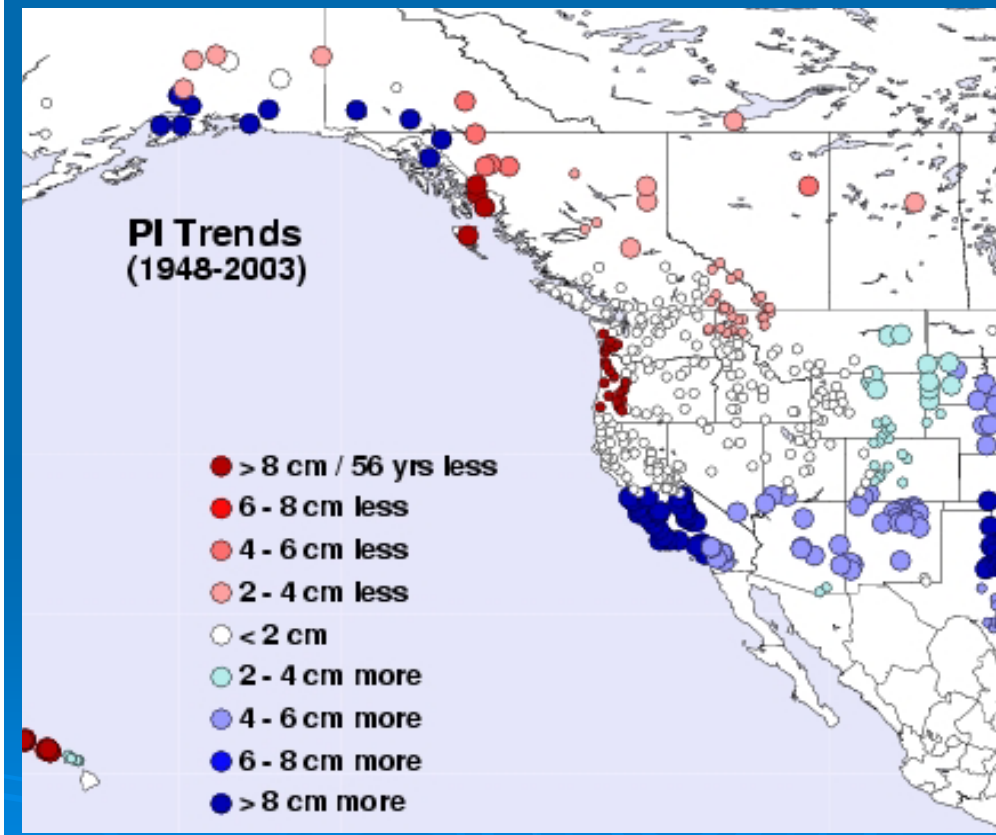

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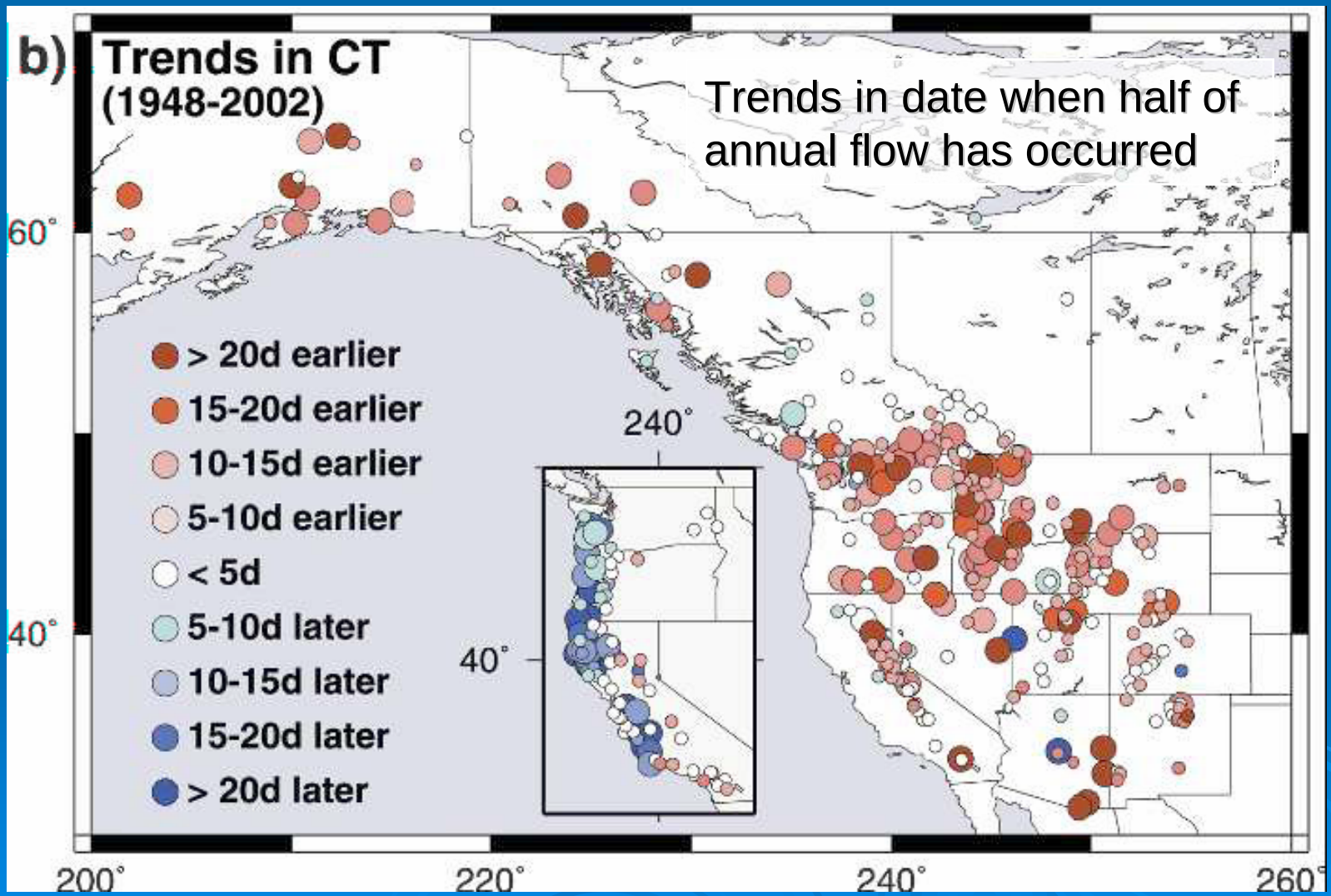

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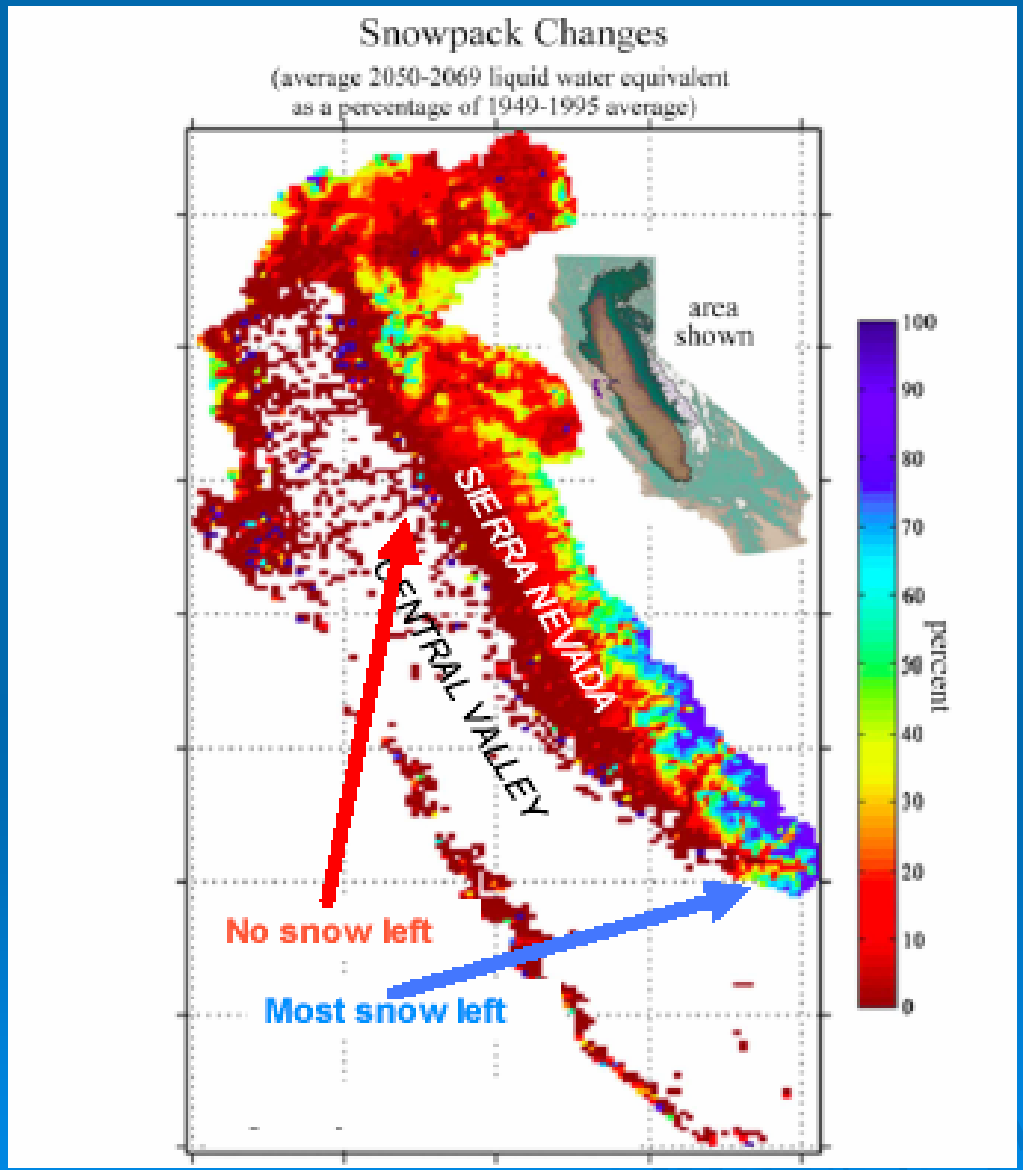

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